



Health and Safety Issues in Natural Disasters

Sponsored by the American Industrial Hygiene Association Indoor Environmental Quality Committee, Biosafety and Environmental Microbiology Committee, Construction Committee, Environmental Issues Committee, Ionizing Radiation Committee, Safety Committee, Incident Preparedness and Response Working Group, and the Wildfire Project Team

Health and Safety Issues in Natural Disasters

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Preface

Disasters can happen anywhere, at any time, often with little to no warning. As specialists in the field of industrial hygiene and safety, the American Industrial Hygiene Association (AIHA) experts have developed and identified these resources to enable recovery efforts while minimizing potential exposures to hazardous materials and conditions.

These resources are not designed for first responders or those industrial hygienists (IHs) involved in emergency planning or the immediate response phase of a given disaster. For industrial hygienists, AIHA has developed a number of technical resources for the IH's role and responsibilities in both emergency preparedness and the incident command system:

- *Industrial Hygienists' Role and Responsibilities in Emergency Preparedness and Response White Paper:*
https://www.aiha.org/get-involved/VolunteerGroups/Documents/IPRWG-EPRWhitePaper_Final.pdf
- Incident Preparedness and Response Working Group Emergency Response documents:
<https://www.aiha.org/get-involved/VolunteerGroups/Pages/Incident-Preparedness-and-Response-Working-Group.aspx>

AIHA strongly encourages IHs and business owners to prepare and plan prior to disasters and to work closely with local emergency operations both before and after disasters strike.

The intention of this collection of resources is to help guide consumers and IHs through the seemingly endless maze of government agencies and private industry references addressing potential hazards that may be encountered after a disaster occurs. The identified resources provide general guidance on the hazards that may be encountered after a disaster. Wildfires, for example, are associated with significant increases of hospital admissions for respiratory distress, asthma, and shortness of breath. The majority of health consequences for major weather-related disasters include injuries associated with evacuation and clean-up, carbon monoxide poisoning (related to the indoor use of gasoline-powered generators), hypothermia, electrocution, wound infections, respiratory illness, cardiovascular disease, and exacerbation of chronic illnesses.

It is important to understand that anyone who ventures into these areas is potentially at risk for exposure to hazards not covered in detail in this document. Even some trained responders to Hurricane Katrina experienced sinus infection and symptoms from mold exposure, confusion from carbon monoxide exposure, slips and falls from lack of sleep, and depression. Therefore, many recovery efforts should be handled with

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professional assistance, particularly when they pose significant risk. Understanding the hazards associated with a disaster enables specially trained IHs to assess the risk, develop, and implement controls, and to reevaluate residual risk as recovery operations continue.

AIHA strongly recommends that the clean-up of hazardous materials be performed or overseen by professionals knowledgeable of the hazards and methods to protect personnel, the public, and the environment. AIHA members consist of health and safety professionals dedicated to protecting worker and public health. To reach out to AIHA safety and health consultants for professional assistance beyond these guidelines, a consultant list is available at <https://www.aiha.org/about-ih/Pages/Find-an-Industrial-Hygienist.aspx>.

BEFORE YOU BEGIN – THE INCIDENT COMMAND SYSTEM (ICS)

When there is an incident, such as a natural or man-made disaster, an Incident Command System (ICS) is typically established for response command, control, and coordination. ICS is a nationally-recognized framework under which all involved or interested entities and stakeholders (whether federal, tribal, state, local, or private) operate. It establishes one command structure with known and scheduled deliverables and uses standardized terminology.

Because the ICS is mandated for disaster response agencies such as the Federal Emergency Management Agency (FEMA), U.S. Environmental Protection Agency (EPA), and U.S. Coast Guard (USCG), it is important to note that the ICS may be in place and active in your area, even if the response phase is over and the recovery phase has begun. It is often best to start by performing a search on an internet search browser for "ICS Liaison" and the name of the event or location to see if the ICS has a website set up. If this does not yield an established website for your response, go to www.disasterassistance.gov and enter the address of the affected property.

If the area inclusive of the address entered has been declared for individual assistance, you can try "Find Assistance" and then "Apply Online" if applicable. If you do not have access to the internet, you may contact FEMA directly:

Call 7 a.m. to 11 p.m. ET, 7 days a week:

*1-800-621-FEMA (1-800-621-3362)

*TTY 1-800-462-7585

*711 or VRS 1-800-621-3362

* You can also email: FEMA-ContactUs@fema.dhs.gov (get a response in 1 to 2 business days) or write to:

FEMA
P.O. Box 10055
Hyattsville, MD 20782-8055

This step is important because the incident command may be able to provide invaluable data about what is happening as well as additional resources before you attempt to return to or enter your home or business.

GENERAL RESPONSE RESOURCES

General disaster relief assistance information is available on these websites:

- **Federal Emergency Management Agency:** How to contact FEMA directly for Disaster Aid: <https://faq.fema.gov/ci/documents/submit>
- **Disaster Assistance:** General website for applying for disaster aid, determining if you are eligible, and finding various assisting agencies. <http://www.disasterassistance.gov/>
- **Disaster Assistance List by Federal Agency:** <http://www.disasterassistance.gov/get-assistance/assistance-by-federal-agency>
- **American Red Cross:** <http://www.redcross.org>

TORNADO-SPECIFIC HAZARDS

Persons entering areas and buildings after a tornadic event face a variety of potential hazards, including but not limited to electrical hazards, structural hazards, displacement of wildlife, exposure to chemicals such as petroleum products or carbon monoxide, and mold growth from water-impacted building materials. First and foremost, life safety issues, such as ensuring the home or building is structurally sound and avoiding electrical shock or carbon monoxide poisoning, must be considered before any entry or clean-up is initiated.

a. Structural Damage and Debris

Damage to a home or business from a tornado or other natural disaster can be obvious or hidden, so be aware of possible structural, electrical, or gas-leak hazards. Tornadoes frequently tear off roofs, shatter windows, and leave the home or business susceptible to water damage. If you have left the area where the damage from a disaster occurred, before returning to your home or business, be sure that local officials have declared that it is safe to enter your community.

Before entering your home or business, look outside for damaged power lines, gas lines, foundation cracks, and other exterior damage. If power lines are down outside your home, do not step in puddles or standing water. Approach entrances carefully. Parts of your home may be collapsed or damaged. See if porch roofs and overhangs have all

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their supports. Try to look inside to check the ceiling and floor for signs of sagging. Water may be trapped in the ceiling, or floors may be unsafe to walk on. Be sure the building is structurally sound. Avoid inspecting your home or business in the dark, unless absolutely necessary, and if you must, use a flashlight rather than a candle or torch to avoid the risk of fire or explosion.

In addition to structural damage concerns, common causes of injury after a tornado include stepping on nails; falling objects; eye injuries from sawdust while using chainsaws; and heavy, rolling objects. Wear sturdy shoes or boots, long sleeves, and gloves, and always wear eye protection such as safety glasses when there is a potential for flying particles and debris.

In general, if you suspect any damage to your home, shut off electrical power, natural gas, and propane tanks to avoid fire, electrocution, or explosions, and do not enter until you are assured it is safe to do so. Contact your local city or county building inspector for information on structural safety codes and standards.

Here are some useful resources to recognize and address these kinds of hazards:

- **Centers for Disease Control and Prevention**
After a Tornado
Information about various hazards found after a tornado.
<https://www.cdc.gov/disasters/tornadoes/after.html>
- **Virginia Tech Emergency Management**
After a Tornado
<http://emergency.vt.edu/ready/guides/tornado/tornado-after.html>

b. Electrical Hazards

Electrical power lines and circuits may have been damaged in a disaster, so look out for fallen wires and take caution when moving about. If a power line falls on your car while driving, stay inside and drive away from the line. Avoid touching any metal or wet object. Be especially cautious of stepping into water, because live electrical lines may have fallen into water and created an electric shock hazard. Never use electrical tools when you are standing in water. If possible and safe, turn off the breaker or remove the fuses in your home when your power is out, especially before connecting a generator to your home's circuit.

Gasoline or diesel-powered generators must be installed and used correctly. If it is necessary to connect a generator to house wiring, have a qualified electrician install appropriate equipment such as an approved automatic interrupt device to prevent a possible fire in the event that your power is suddenly restored while operating the generator. It would be preferable to have the interrupt device installed prior to the disaster when resources and trained electricians are widely available. Check the

generator's maximum amperage load and do not exceed it. Always place these generators outside and away from the structure to prevent carbon monoxide poisoning. If thunderstorms occur, seek a sturdy shelter or a car, or stay low to the ground outdoors. Avoid standing near a tree in a thunderstorm. If you are indoors during a thunderstorm, turn off computers and appliances.

Additional guidance for homeowners and small business owners is provided at:

- **Electrical Safety Foundation International**
Home Disaster Safety
<http://www.esfi.org/disaster-safety>
- **Centers for Disease Control and Prevention**
Natural Disasters and Severe Weather, Protect Yourself and Others from Electrical Hazards After a Disaster
<http://www.cdc.gov/disasters/electrical.html>

Sources of technical guidance for the industrial hygienist include:

- **Centers for Disease Control and Prevention**
Natural Disasters and Severe Weather, Electrical Safety and Generators
<http://www.cdc.gov/disasters/elecgenerators.html>
- **National Electrical Manufacturers Association**
Evaluating Water-Damaged Electrical Equipment, NEMA GD 1-2016
<http://www.nema.org/Standards/Pages/Evaluating-Water-Damaged-Electrical-Equipment.aspx#download> (Note: Free membership and account creation required to download)
- **National Electrical Manufacturers Association**
Evaluating Fire- and Heat-Damaged Electrical Equipment, NEMA GD 2-2016
<https://login.nema.org/default.aspx?returnurl=https://www.nema.org/standards/pages/evaluating-fire-and-heat-damaged-electrical-equipment.aspx> (Note: Free membership and account creation required to download)

c. Natural Gas and Other Fuels

Many modern homes contain gas-fired appliances such as water heaters, furnaces, and cooking surfaces. Gas used as fuel is always flammable and may ignite in the presence of an ignition source such as a lighter or other spark-producing device. Flammable fuel service to a home may include natural gas, propane, or fuel oil. Each service may become damaged as a result of physical damage to a home, such as from a tornado or from other event that displaces the home slightly, such as an earthquake. Such damage may cause a fuel leak in the home that may be difficult to detect.

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An inadvertent ignition source or spark may ignite a fuel leak, resulting in an explosion and further damage to the structure and injury to the occupants. As a result, the home distribution and fuel delivery systems should be inspected immediately following an event that resulted in or could have resulted in physical damage to the piping or fuel distribution structure inside or immediately outside the home.

Such an inspection should occur with the power disconnected and should include the use of a direct-reading combustible gas or volatile organic compound (VOC) detector. The inspection should start at the fuel delivery source - such as a gas meter, or propane storage tank - shut off. Here are some useful resources to recognize and address these kinds of hazards:

- **Consumer Product Safety Commission**
Consumer Safety Pamphlet
Information about various hazards associated with natural gas appliances
http://www.wardmfg.com/wp-content/uploads/2014/08/02_Safety_Pamphlet-Updated_December_2012.pdf
- **CSA Group**
Severe Weather Aftermath: Tips from CSA Group to Help Recover from Damage
General information related to home safety following a tornado or flood event
<http://www.csagroup.org/csa-group-news/news-releases/item/?n=severe-weather-aftermath-tips-from-csa-group-to-help-recover-from-damage>
- **American Gas Association**
Kids & Natural Gas Safety
Video aimed at educating youth on natural gas safety in the home
<https://www.aga.org/node/5614>
- **National Weather Service**
Severe Weather, After a Tornado
General safety tips outlining safety precautions following a tornado event
<http://www.nws.noaa.gov/om/tornado/after.shtml>

Technical resources for the IH include:

- **American Industrial Hygiene Association**
Gas Monitoring Body of Knowledge
<https://www.aiha.org/publications-and-resources/BoKs/DRI-Gas/Pages/BoK-DRI-Gas-Monitoring.aspx>
- **Centers for Disease Control and Prevention**
Health Effects of Cut Gas Lines and Other Petroleum Product Release Incidents
Mortality & Morbidity Weekly Report
<http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6422a1.htm>

d. Hazardous Materials (Asbestos, Lead, Petroleum Products, etc.)

Hazardous materials and conditions may be present as a result of damaged building materials containing lead or asbestos as well as sewage-contaminated items, or hazardous materials such as chemicals or cleaning products. In many cases, these building materials are damaged and dislodged during a natural disaster, resulting in the potential for airborne exposure to fibers and particles. Homeowners should be aware of this potential, and they should take extra precautions when encountering these materials.

In addition, the release of petroleum products, such as heating oil and gasoline stored in the garage or in a vehicle, into a home or other building can lead to airborne contamination as well as contamination of the building materials, soil, and groundwater.

For homeowners, here are some useful resources to recognize and address these kinds of hazards:

- **U.S. Department of Housing and Urban Development**

Disaster Recovery

Addresses mold, lead, asbestos, drinking water, and natural gas concerns

http://portal.hud.gov/hudportal/HUD?src=/program_offices/healthy_homes/disaster_recovery

- **Centers for Disease Control and Prevention**

Fact Sheet: Clean Up Safely After a Disaster

Addresses carbon monoxide, sewage, heat-related illnesses, chemicals, water, and hygiene and infectious disease issues

<http://emergency.cdc.gov/disasters/cleanup/facts.asp>

Protect Yourself From Chemicals Released During a Natural Disaster

Addresses chemicals in general, household chemicals, and oil spills

<http://emergency.cdc.gov/disasters/chemicals.asp>

- **U.S. Environmental Protection Agency**

Natural Disaster: Flooding

Addresses carbon monoxide, mold, lead, asbestos and underground storage tanks

<http://www2.epa.gov/natural-disasters/flooding>

Flood Cleanup: Avoiding Indoor Air Quality Problems Fact Sheet

Addresses microbial growth, carbon monoxide, lead and asbestos

<http://www2.epa.gov/sites/production/files/2015-09/documents/floods.pdf>

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- **U.S. Department of Health and Human Services, National Institutes of Health, National Institute of Environmental Health Services**
Safety Awareness for Responders to Hurricanes: Protecting Yourself While Helping Others Addresses heat and cold stress, noise, dust, chemicals, carbon monoxide and many other issues
http://tools.niehs.nih.gov/wetp/public/hasl_get_blob.cfm?ID=9716

Technical resources for the IH include:

- **Occupational Safety and Health Administration**
Safety & Health Topics - Asbestos
<https://www.osha.gov/SLTC/asbestos/hazards.html>
- **Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health**
Workplace Safety & Health Topics – Asbestos
<http://www.cdc.gov/niosh/topics/asbestos/>

Toxicological Profile for Asbestos
<http://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=30&tid=4>
- **U.S. Environmental Protection Agency**
Learn About Asbestos
<https://www.epa.gov/asbestos>

e. Heat Stress/Cold Stress

Extreme heat or cold conditions may occur during emergency situations and be exacerbated by loss of heating and cooling during power outages. People also tend to work harder than usual when responding to an emergency, so the body may not be acclimated to a heavy workload under temperature extremes.

Some tips for working under hot conditions include:

- Keep hydrated. Frequently drink small amounts of water, even before you get thirsty. Avoid alcohol, caffeine, and drinks with high sugar content.
- Eat light, non-greasy meals.
- Wear light-weight, light-colored, loose-fitting clothing.
- Schedule heavy tasks earlier in the day or at a time during the day when the heat index is lower.
- Take frequent rest breaks in a shaded or cool area.
- Recognize heat stress signs and symptoms:
 - Heat exhaustion - heavy sweating; cool, moist skin; fast, weak pulse with fast shallow breathing; paleness; faintness; cramping; tiredness; headache; dizziness; nausea; or vomiting

- Heat stroke - no sweating; red, hot, dry skin; rapid, strong pulse; dizziness; nausea; headache; confusion; uncontrolled twitching; or unconsciousness
- Heat cramps - usually occur in the abdomen, arms, or legs
- Heat rash - painful, red cluster of pimples or small blisters most likely on neck, upper chest, in groin area, under breast, or at the elbow or knee creases
- Heat exhaustion and heat stroke are emergencies that can lead to death. Call for emergency assistance (e.g. 911). Then, *gently* move the victim to a cool and/or shady area. Loosen clothing, remove footwear, and elevate legs. Cool the victim by using cool water or cold packs; in low humidity, wet cloths can be used.

Additional guidance related to working in hot conditions may be found as follows:

- **Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health**
Heat Stress
<http://www.cdc.gov/niosh/topics/heatstress/>
- **Occupational Safety and Health Administration**
Water. Rest. Shade: OSHA's Campaign to Prevent Heat Illness in Outdoor Workers
<https://www.osha.gov/SLTC/heatillness/index.html>

Technical guidance for the industrial hygienist includes:

- **American Conference of Governmental Industrial Hygienists**
Various books, posters and presentations
<http://www.acgih.org/search?query=heat%20stress>
See TLV-BEI booklet for heat stress limits
- **Occupational Safety and Health Administration**
OSHA Technical Manual Section III Chapter 4 Heat Stress
https://www.osha.gov/dts/osta/otm/otm_iii/otm_iii_4.html

Some tips for working under cold conditions include:

- Even 60 degrees Fahrenheit can be “cold” when a person is also wet.
- Wear a warm head, face and ear covering and layered clothing:
 - 1st layer - material that allows the skin to breathe by allowing sweat to escape such as polypropylene or knitted silk.
 - 2nd layer - material that absorbs perspiration, but does not allow heat to escape such as polypropylene fleece or other synthetic fibers.
 - 3rd layer - material that traps body heat and keeps water or dampness out such as quilted coats filled with down or a lightweight microfiber and have a waterproof outer layer. If the coat is not waterproof, wear a water-resistant shell or windbreaker. The outer layer should include provisions for ventilation to prevent inner layers from becoming wet from sweat. For

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higher wind speeds and lower temperatures in the work area, higher insulation values of protective clothing are required.

- Wear waterproof boots to protect feet. If boots have liners, replace them when damp.
- Wear gloves or preferably mittens to protect hands. Replace when damp.
- When working outside in a snow and/or ice-covered terrain, wear special safety glasses with side shields or goggles to protect against UV light, glare, and blowing ice crystals.
- Drink plenty of non-alcoholic fluids to prevent dehydration and exhaustion. Heated drinks are helpful, but limit intake of caffeine.
- Take regular breaks to get out of the cold environment. *Note:* When taking a break, remove at least the outer layer of clothing and loosen remaining layers to permit sweat to evaporate. If clothing is wet, change into dry clothes before returning to a cold environment.
- Recognize hypothermia's warning signs:
 - In adults – shivering, exhaustion, confusion, fumbling hands, memory loss, slurred speech and drowsiness
 - In infants – bright red, cold skin; very low energy

Hypothermia is an emergency that can lead to death. If a person has the above symptoms and his or her temperature is below 95 degrees Fahrenheit, call for emergency assistance. Gently move the victim to a warm area and begin warming him or her.

Additional guidance related to working in cold conditions may be found as follows:

- **Centers for Disease Control and Prevention National Institute for Occupational Safety and Health**
Cold Stress
<http://www.cdc.gov/niosh/topics/coldstress/>

NIOSH Fast Facts: Protecting Yourself from Cold Stress
<http://www.cdc.gov/niosh/docs/2010-115/pdfs/2010-115.pdf>
- **US Department of Health and Human Services/Centers for Disease Control and Prevention**
Extreme Cold: A Prevention Guide to Promote Your Personal Health and Safety
<http://emergency.cdc.gov/disasters/winter/pdf/extreme-cold-guide.pdf>
- **Canadian Centre for Occupational Health and Safety**
Cold Environments: Working in the Cold
https://www.ccohs.ca/oshanswers/phys_agents/cold_working.html

Outside Workers to Battle the Cold
<http://www.ccohs.ca/headlines/text123.html>

Technical guidance for the industrial hygienist includes:

- **American Conference of Governmental Industrial Hygienists**

Various books, posters and presentations

<http://www.acgih.org/search?Query=cold+stress>

See TLV-BEI booklet for cold stress limits

f. Carbon Monoxide

Carbon monoxide (CO) is a colorless, odorless gas that is a combustion byproduct. CO is a chemical asphyxiant that interferes with the body's ability to re-oxygenate blood and is a common, unfortunate cause of death for many home occupants each year. Homes and commercial structures that are fueled by a hydrocarbon such as natural gas, propane, or fuel oil will generate CO during combustion. This is especially true during peak, seasonal heating demand, such as winter months, when homes may not exchange as much outdoor air.

It is imperative that CO from fuel combustion processes such as generators, hot water heaters or furnaces is adequately vented outside the home. Physical damage to the home, such as following a tornado or earthquake, may damage or compromise home combustion venting apparatus. Inadequate venting or excessive or poorly mixed combustion may result in a CO build up in a home and significant risk to its occupants.

More information on carbon monoxide may be found at:

- **Consumer Product Safety Commission**

Carbon Monoxide Fact Sheet

<https://www.cpsc.gov/safety-education/safety-guides/carbon-monoxide/carbon-monoxide-fact-sheet>

- **Centers for Disease Control and Prevention**

Carbon Monoxide Poisoning After a Disaster

<http://www.cdc.gov/disasters/carbonmonoxide.html>

g. Water Damage

Rain is often associated with tornadic activity. If possible, wet building materials and contents should be dried as soon as possible (preferably within 24-48 hours) to prevent mold growth. If the electrical power service is not available in the 24-48 hours following the event, mold and bacterial contamination should be expected in areas where water impaction has occurred.

If the overall amount of impacted materials is less than about 10 square feet, the CDC has guidance for homeowners and renters for entry and clean-up at http://www.cdc.gov/mold/pdfs/homeowners_and_renters_guide.pdf, and the EPA has guidance on how to address mold clean-up on your own at

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https://www.epa.gov/sites/production/files/2014-08/documents/flood_booklet_en.pdf

Be sure to read the label and follow all manufacturer's recommendations when using any chemical disinfectant for cleaning purposes. Because of the significant risk for adverse respiratory effects and the caustic nature of bleach, the use of bleach for cleaning purposes must be approached with caution. FEMA notes in its guidance on cleaning flooded buildings found at https://www.fema.gov/media-library-data/1381405548275-ec9f9b9de186f1874b92ecda6c33182b/SandyFactsheet1CleaningFloodedBldgs_508_FINAL2.pdf that while bleach is convenient as a cleaner and stain remover for hard, non-porous items, it has distinct drawbacks when cleaning water-damaged materials. Many types of bleach are not EPA-registered as a disinfectant. Furthermore, bleach's effectiveness in killing bacteria and mold is significantly reduced when it comes in contact with residual dirt, which is often present after a disaster. Also, if bleach water comes into contact with electrical components and other metal parts of mechanical systems it can cause corrosion. Bleach water can also compromise the effectiveness of termite treatments in the soil surrounding the building.

If significant mold or other sewage contamination has occurred, however, it is recommended that business owners and homeowners seek professional guidance before attempting to clean large amounts of contaminated materials. Industrial hygienists and other safety and health professionals can anticipate health and safety concerns and design solutions to prevent exposures using guidelines established by government agencies and institutions such as the Institute of Inspection, Cleaning and Restoration Certification.

Be cautious when considering hiring contractors to perform mold remediation. The District of Columbia and some states, such as Florida, Maryland, Texas, Louisiana, New Hampshire, New York require licensure or certification for mold assessors and mold remediators. Guidelines for evaluating contractors can be found at the following sources:

- **Texas A&M University System**
Selecting Mold Remediation Contractors
<http://agrifecdn.tamu.edu/aes/files/2010/05/SelectingMoldRemediationContractors.pdf>
- **Cornell University/Louisiana State University**
Hiring a Mold Remediation Contractor
<http://extensionhealthyhomes.org/Documents/Mold-remediation.pdf>

Other sources of guidance related to mold response are:

- **Centers for Disease Control and Prevention**
Mold after a Disaster
<http://emergency.cdc.gov/disasters/mold/>

- **Federal Emergency Management Agency**
Mold & Mildew: Cleaning Up Your Flood Damaged Home
<https://www.fema.gov/media-library/assets/documents/12385>

Dealing with Mold & Mildew in your Flood-Damaged Home
https://www.fema.gov/pdf/rebuild/recover/fema_mold_brochure_english.pdf
- **American Industrial Hygiene Association**
Facts About Mold
<https://www.aiha.org/publications-and-resources/TopicsofInterest/Hazards/Pages/Facts-About-Mold.aspx>

Professional Services Listing
<https://www.aiha.org/about-ih/Pages/Find-an-Industrial-Hygienist.aspx>
 (specialty: mold)
- **Canadian Centre for Occupational Health and Safety**
OSH Answer Fact Sheets: Indoor Air Quality – Moulds and Fungi
http://www.ccohs.ca/oshanswers/biol_hazards/iaq_mold.html
- **U.S. Environmental Protection Agency**
A Brief Guide to Mold, Moisture, and Your Home
<https://www.epa.gov/mold/brief-guide-mold-moisture-and-your-home>
- **Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health**
NIOSH Interim Recommendations for the Cleaning and Remediation of Flood-Contaminated HVAC Systems: A Guide for Building Owners and Managers
<http://www.cdc.gov/niosh/topics/emres/Cleaning-Flood-HVAC.html>
- **Occupational Safety and Health Administration**
Fungi Hazards and Flood Cleanup
https://www.osha.gov/OshDoc/data_Hurricane_Facts/Bulletin3.pdf
- **Federal Emergency Management Agency**
Mold & Mildew: Cleaning Up Your Flood Damaged Home
<https://www.fema.gov/media-library/assets/documents/12385>

Dealing with Mold & Mildew in Your Flood Damaged Home
https://www.fema.gov/pdf/rebuild/recover/fema_mold_brochure_english.pdf

For the industrial hygienist, it is critical to understand and convey the importance of respiratory protection if clean-up is initiated. Approximately 6 months after Hurricane Katrina, a questionnaire-based study was done on 600 people involved in the clean-up in New Orleans. Respiratory symptom scores increased linearly with

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exposure in water-damaged homes. Disposable-respirator use was associated with lower odds of exacerbation of moderate or severe symptoms inside water-damaged homes.

Technical guidance for the industrial hygienist includes:

- Cummings, K.J., J. Cox-Ganser, M.A. Riggs, N. Edwards, G.R.Hobbs, and K. Kreiss: "Health effects of exposure to water-damaged New Orleans homes six months after hurricanes Katrina and Rita." *Am J Public Health* 98:869-875 (2008).

- **American Industrial Hygiene Association**

Facts About Mold for the Professional

<https://www.aiha.org/publications-and-resources/TopicsofInterest/Hazards/Pages/Facts-About-Mold.aspx>

Recognition, Evaluation and Control of Indoor Mold, also known as the Green Book

<https://www.aiha.org/Lists/Products/DispForm.aspx?ID=50>

- **Institute of Inspection Cleaning and Restoration Certification**

ANSI/IICRC S500 Water Damage Restoration: Standard and Reference Guide for Professional Water Damage Restoration

<http://www.iicrc.org/standards/iicrc-s500/>

ANSI/IICRC S520 Mold Remediation: ANSI/IICRC S520 Standard and IICRC R520 Reference Guide for Professional Mold Remediation

<http://www.iicrc.org/standards/iicrc-s520/>

h. Other Biological Hazards and Infectious Agents

Heavy rains during or after a tornado may result in flooding or standing water. Floodwater and standing waters often contains infectious organisms including gastrointestinal bacteria such as *E. coli*, *Salmonella*, and *Shigella*; hepatitis A virus; and agents of typhoid, paratyphoid, and tetanus. Moreover, pools of standing or stagnant water can become breeding grounds for mosquitoes, increasing the risk of encephalitis, West Nile virus, Zika, or other mosquito-borne diseases. The presence of wild or stray animals in populated areas increases the risk of diseases caused by animal bites (e.g., rabies) as well as diseases carried by fleas and ticks.

To avoid bacterial and viral exposures, keep children and pets out of standing water and contaminated materials. Hands should be cleaned regularly by either hand-washing with soap and water or using an alcohol-based hand sanitizer (containing 60%-95% alcohol). When hands are visibly soiled or dirty, it is best to wash your hands with soap and clean running water for 20 seconds.

To protect yourself and your family from animal- and insect-related hazards, avoid wild or stray animals, use insect repellent that contains DEET or picaridin, and wear long

pants, socks, and long-sleeved shirts. Drain standing water in open containers to minimize mosquito breeding places.

Livestock might no longer be confined after a disaster, and the pollution they generate may contaminate surface waters used for drinking. Loose dogs or other roaming animals may be lost, frightened, or hurt, and more likely to bite. The CDC recommends that you not feed, approach, or call a dog you do not know.

Rats and mice can spread disease, contaminate food, and destroy property. Remove food sources and other items that can provide shelter for rodents. Keep food and water (including pet food) in containers made of thick plastic, glass, or metal that have a tight-fitting lid to keep rodents out. For more information, see the following:

- **Centers for Disease Control and Prevention**

Protect Yourself from Animal and Insect-Related Hazards after a Disaster

<https://www.cdc.gov/disasters/animalhazards/facts.html>

Rodent Control after a Disaster

<https://www.cdc.gov/disasters/rodents.html>

Stray Dogs in Hurricane Disaster Areas

<https://www.cdc.gov/disasters/hurricanes/pdf/hurricaneflyer-straydogs.pdf>

Contaminated drinking water is the top reason for illness after most disasters. If municipal water sources have been impacted, use one of the following for handwashing, drinking, teeth-brushing, and cleaning children's toys:

- Bottled water
- Water that has been boiled for one minute then cooled
- Water that has been disinfected with 1/8 teaspoon of household bleach per 1 gallon of water or 1/4 teaspoon per gallon of cloudy water (allow it to stand for 30 minutes before use)

The following are resources for home and small business owners:

- **Centers for Disease Control and Prevention**

Provides information on infectious diseases, wound infections, chemical hazards, and animal and insect bites

Flood Water After a Disaster or Emergency

<https://www.cdc.gov/disasters/floods/cleanupwater.html>

- **Occupational Safety and Health Administration**

Flood Cleanup Fact Sheet

<https://www.osha.gov/OshDoc/data/HurricaneFacts/floodcleanup.html>

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- **Illinois Department of Public Health**
Addresses mosquitoes and animals, drinking and cooking water, food safety, and how to disinfect a well
After the Flood
<http://www.idph.state.il.us/pdf/AfterTheFlood.pdf>
- **Federal Emergency Management Agency**
Hurricane Sandy Recovery Fact Sheet: Cleaning Flooded Buildings
https://www.fema.gov/media-library-data/1381405548275-ec9f9b9de186f1874b92ecda6c33182b/SandyFactsheet1CleaningFloodedBldgs_508_FINAL2.pdf

Technical resources for the IH include:

- Centers for Disease Control and Prevention: “Infectious disease and dermatologic conditions in evacuees and rescue workers after Hurricane Katrina - multiple states, August-September, 2005.” *MMWR* 54:961 (2005).
- Cummings, K.J., J. Cox-Ganser, M.A. Riggs, N. Edwards, G.R.Hobbs, and K. Kreiss: “Health effects of exposure to water-damaged New Orleans homes six months after hurricanes Katrina and Rita.” *Am J Public Health* 98:869–875 (2008).
- Emerson, J.B., P.B. Keady, T.E. Brewer, N. Clements, E.E. Morgan, J. Awerbuch, and N. Fierer: “Impacts of flood damage on airborne bacteria and fungi in homes after the 2013 Colorado Front Range flood.” *Environ Sci Technol* 49:2675–2684 (2015).
- Jones, E.K., K.G. Sumner, and M. Gochfeld: “Residential flood damage after hurricane Floyd, mold, household remediation, and respiratory health.” *Remediation J* 24:107–120 (2013).
- Ligon, B.L.: “Infectious diseases that pose specific challenges after natural disasters: a review.” *Semin Pediatr Infect Dis* 17:36–45 (2006).
- Lin, C.J., T.J. Wade, and E.D. Hilborn: “Flooding and *Clostridium difficile* infection: a case-crossover analysis.” *Int J Environ Research Public Health* 12:6948–6964 (2015).
- McKenzie, L.B., N. Ahir, U. Stolz, and N.G. Nelson: “Household cleaning product-related injuries treated in U.S. emergency departments in 1990–2006.” *Pediatrics* 126:509–16 (2010).

i. Radiation From Smoke Detectors and Exit Lighting

After natural disasters, homeowners, business owners, and response personnel may

encounter some items containing radioactive materials, most notably smoke detectors and commercial exit lights. Smoke detectors are ubiquitous in most buildings, including residential, commercial, and institutional facilities, since there are code requirements to have them in most jurisdictions. Most smoke detectors use a very small radioactive source, generally americium-241. However, the level of radiation emitted from a smoke detector is insufficient to create a public health hazard, and there are no federal regulatory requirements for disposal.

Dislocated or damaged smoke detectors may or may not be suitable for reinstallation. Because smoke detectors save lives, if there is any doubt about the suitability of a device, it may be prudent to exercise precaution and purchase a new smoke detector unit. In general, if damaged or unusable, the recovered smoke detector should be returned to the manufacturer if at all possible. Consult local fire protection agencies for advice.

Tritium exit lights are generally found in some commercial and institutional facilities, especially in locations where electrical power is not available or difficult to run. Tritium exit signs are devices similar in appearance to exit signs operated by AC or DC electrical circuits, but the difference is that tritium exit signs provide illumination from sealed glass tubes inside the unit that contain tritium gas, a radioactive isotope of hydrogen. The tritium gas emits beta particles that interact within the tube to produce the illumination.

As long as the glass tube within the sign remains unbroken, there is little risk of radiation exposure. However, if this internal glass tube becomes broken, there is some risk of exposure. If the word "Exit" is not fully or partially illuminated, this is an indication that the tritium gas has escaped. As a gas, the tritium will dissipate over time. The rate of dissipation depends on the ventilation rate in the vicinity.

The greatest risk to people occurs when the tritium exit sign first breaks or there is an indication that there is escaping gas leakage. If a tritium exit sign is broken, leave the area immediately. Consult an industrial hygienist, safety professional, or the state radiation office listed at <https://scp.nrc.gov/asdirectory.html>.

Disposal of tritium exit signs is highly regulated. They must not be disposed in normal trash or abandoned. If you encounter a displaced tritium exit light, consult with an industrial hygienist or contact the state radiation office in the link above.

Additional resources may be found at:

- **Nuclear Regulatory Commission**
Backgrounder on Tritium Exit Signs
<http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/fs-tritium.html>
- **U.S. Environmental Protection Agency**
Tritium in Exit Signs
<https://www3.epa.gov/radtown/tritium-exit-signs.html>

FLOOD HAZARDS

Persons entering areas and buildings subject to flooding face a variety of potential hazards, including but not limited to electrical hazards, structural hazards, displaced wildlife, exposure to chemicals and sewage in contaminated floodwater, and mold growth from water-impacted building materials. First and foremost, life safety issues, such as avoiding electrical shock and carbon monoxide poisoning, must be considered before any clean-up or response is initiated.

General guidance on some of these hazards is provided in the resources identified for the home- and business owner. However, AIHA strongly recommends that clean-up of hazardous materials be performed or overseen by professionals knowledgeable of both the hazards and the methods to protect occupants and the environment.

a. Before Entering Your Home

Hazards in and around flooded buildings include risk of structural collapse, electrical hazards, sewage contamination, trip and fall injuries, fire and explosion hazards where natural gas or bottled gas are present, and loose or broken gas piping and gas leaks. Guidance for preparing to enter your home may be found at these websites:

- **Centers for Disease Control and Prevention**
Reentering Your Flooded Home
<http://emergency.cdc.gov/disasters/mold/reenter.asp>

Inside the Home
<http://emergency.cdc.gov/disasters/floods/cleanupwater.asp>
- **The Canadian Mortgage and Housing Corporation**
After the Flood – A Homeowner’s Checklist
http://publications.gc.ca/collections/collection_2008/cmhc-schl/nh18-24/NH18-24-7-2008E.pdf or <http://open.canada.ca/vl/en/dataset/publications-333113>
- **Health Canada**
Flood Cleanup: Keep in Mind Indoor Air Quality
<http://healthycanadians.gc.ca/publications/healthy-living-vie-saine/flood-inondation/alt/flood-inondation-eng.pdf> and
<http://healthycanadians.gc.ca/publications/healthy-living-vie-saine/flood-inondation/index-eng.php>
- **U.S. Department of Health and Human Services, National Institutes of Health, National Institute of Environmental Health Services**
Protecting Yourself While Removing Post-Disaster Debris from your Home or Business
https://tools.niehs.nih.gov/wetp/public/hasl_get_blob.cfm?id=9295

- **InspectAPedia**

Building Entry, Cleanup & Repair After a Flood or Other Disaster

http://inspectapedia.com/Building_Damage/Flood_Damage_Checklist.php#Checklist

First Priorities: What to Do After a Building has Been Flooded

http://inspectapedia.com/Building_Damage/Flood_Damage_Checklist.php#H1

b. Electrical Hazards

Flooding caused by hurricanes and storms can create significant electrical safety hazards. Floodwater contaminants can create serious fire hazards if electrical wiring and equipment have been submerged in water. Even with professional cleaning and drying, sediments and toxins are difficult to remove.

After a flood, dealing with the hazards is not a do-it-yourself project. Before energizing a circuit, you should have a qualified electrician or electrical inspector check it thoroughly to assess the extent of the damage, and only then proceed with repair or replacement. Underwriters Laboratories (UL) (http://cms.ul.com/wp-content/uploads/2014/06/UL_Flood_Electrical_Equipment_WP_V4.pdf) offers these important safety tips:

- Do not flip on a switch or plug in an appliance until an electrician confirms it is safe.
- Do not touch a circuit breaker or replace a fuse with wet hands or while standing on a wet surface. Use a dry plastic or rubber-insulated tool to reset breakers, and use only one hand.
- Do not allow power cord connections to become wet. Do not remove or bypass the ground pin on a three-prong plug.
- Use portable ground-fault circuit-interrupters (GFCIs) to help prevent electrical shock injuries.
- If electrical devices such as circuit breakers, receptacles, and switches have been submerged, discard and replace them.
- When using a wet-dry vacuum cleaner or pressure washer, follow the manufacturer's instructions to avoid electrical shock.

Often after a flood there is a question as to whether you should replace or recondition electrical equipment. Corrosion and insulation damage can occur when water and silt get inside electrical products. Water can also damage motors in electrical appliances.

Therefore, you should be prepared to replace:

- Circuit breakers and fuses
 - All electrical wiring systems
 - Light switches, thermostats, outlets, light fixtures, electric heaters, and ceiling fans
 - Furnace burner and blower motors, ignition transformers, elements, and relays
 - Hot water heaters
-

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- Washing machines, furnaces, heat pumps, refrigerators, and similar appliances.
- Electronic equipment, including computers and home entertainment systems.
- Air conditioners
- Non-submersible pumps
- Boilers

The writers at *Popular Mechanics* magazine

(<http://www.popularmechanics.com/adventure/outdoors/tips/a8231/4-rules-for-electrical-safety-after-a-flood-14261065/>) caution against going into a flooded

basement until the utility department, fire department, or a licensed electrician has removed the home's electrical meter from its socket. Removing the meter from the socket is the only way the house can be completely disconnected from the grid.

Even if you have no power, you can still be electrocuted in a flooded basement if someone is running a generator nearby and back-feeding electricity into a storm-damaged grid. Even after the building is fully disconnected from the grid, never go into a flooded building alone. Put on chest waders and bring a bright flashlight that clips to your hat or your waders so you do not have to carry it. Have someone standing by in case you need help.

Additional precautions are offered by Electrical Safety Authority

([https://www.esasafe.com/assets/files/esasafe/pdf/Communications/Electrical Safety and Water Damaged Electrical Equipment.pdf](https://www.esasafe.com/assets/files/esasafe/pdf/Communications/Electrical_Safety_and_Water_Damaged_Electrical_Equipment.pdf)):

- Move dangerous chemicals such as weed killers, insecticides, and corrosives to dry areas to reduce the chance of contaminating electrical equipment.
- Shut off all electrical power and the gas supply valve to any gas-fired appliance prior to flooding, if possible. Shut off the electrical supply to all oil-fired equipment.

More information on electrical hazards and electrical appliances and equipment can be found at:

- **Electrical Safety Foundation International**
Flood Safety
<http://files.esfi.org/file/Flood-Safety.pdf>

c. Hazardous Materials and Conditions

Hazardous materials and conditions may be present as a result of damaged building materials containing lead or asbestos, sewage-contaminated items, or hazardous materials such as chemicals or cleaning products present in floodwater. Heat stress and cold stress may be present when working long hours. Fire and carbon monoxide poisoning from combustion sources may also be a concern. Here are some useful resources to recognize and address these kinds of hazards:

- **U.S. Department of Housing and Urban Development**
Disaster Recovery
 Addresses mold, lead, asbestos, drinking water, and natural gas concerns
http://portal.hud.gov/hudportal/HUD?src=/program_offices/healthy_homes/disaster_recovery
- **Centers for Disease Control and Prevention**
Fact Sheet: Clean Up Safely After a Disaster
 Addresses carbon monoxide, sewage, heat-related illnesses, chemicals, water, and hygiene and infectious disease issues
<http://emergency.cdc.gov/disasters/cleanup/facts.asp>
- *Protect Yourself From Chemicals Released During a Natural Disaster*
 Addresses chemicals in general, household chemicals, and oil spills
<http://emergency.cdc.gov/disasters/chemicals.asp>
- **U.S. Environmental Protection Agency**
Natural Disaster: Flooding
 Addresses carbon monoxide, mold, lead, asbestos, and underground storage tanks
<http://www2.epa.gov/natural-disasters/flooding>

Flood Cleanup: Avoiding Indoor Air Quality Problems Fact Sheet
 Addresses microbial growth, carbon monoxide, lead, and asbestos
<http://www2.epa.gov/sites/production/files/2015-09/documents/floods.pdf>
- **U.S. Department of Health and Human Services, National Institutes of Health, National Institute of Environmental Health Services**
Safety Awareness for Responders to Hurricanes: Protecting Yourself While Helping Others
 Addresses heat and cold stress, noise, dust, chemicals, carbon monoxide, and many other concerns
http://tools.niehs.nih.gov/wetp/public/hasl_get_blob.cfm?ID=9716

d. Mold and Other Microbial Growth

If possible, wet building materials and contents should be dried as soon as possible (preferably within 24-48 hours) to prevent mold growth. When a flood event occurs as part of a widespread natural disaster, the electrical power service and professional services necessary to actually begin cleaning, disinfecting and drying of building materials are not normally available in the 24-48 hours following the event, and can take up to several weeks before roads are cleared, power is on and equipment and people are available to clean, disinfect, and dry the building. This means that mold and bacterial contamination should be expected after a significant flooding event. Guidance for small-scale cleanup can be found as follows:

- If the overall amount of impacted materials is less than about 10 square feet, the

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CDC has guidance for homeowners and renters for entry and clean-up at http://www.cdc.gov/mold/pdfs/homeowners_and_renters_guide.pdf.

- The EPA has guidance on how to address mold clean-up on your own at <https://www.epa.gov/mold/brief-guide-mold-moisture-and-your-home>

Be sure to read the label and follow all manufacturer's recommendations when using any chemical disinfectant for cleaning purposes. Because of the significant risk for adverse respiratory effects and the caustic nature of bleach, the use of bleach for cleaning purposes must be approached with caution. FEMA notes in its guidance on cleaning flooded buildings found at https://www.fema.gov/media-library-data/1381405548275-ec9f9b9de186f1874b92ecda6c33182b/SandyFactsheet1CleaningFloodedBldgs_508_FINAL2.pdf that while bleach is convenient as a cleaner and stain remover for hard, non-porous items, it has distinct drawbacks when cleaning water-damaged materials. Many types of bleach are not EPA-registered as a disinfectant. Furthermore, bleach's effectiveness in killing bacteria and mold is significantly reduced when it comes in contact with residual dirt, which is often present after a disaster. Also, if bleach water comes into contact with electrical components and other metal parts of mechanical systems it can cause corrosion. Bleach water can also compromise the effectiveness of termite treatments in the soil surrounding the building.

If significant mold or other sewage contamination has occurred, however, it is recommended that business owners and homeowners seek professional guidance before attempting to clean large amounts of contaminated materials. Industrial hygienists and other safety and health professionals can anticipate health and safety concerns and design solutions to prevent exposures using guidelines established by government agencies and institutions such as the Institute of Inspection, Cleaning and Restoration Certification.

Be cautious when considering hiring contractors to perform mold remediation. Some states, such as Florida, Texas, Louisiana, New Hampshire, New York and others require licensure for mold assessors and mold remediators, so be sure to check your state's requirements. Guidelines for evaluating contractors can be found at the following sources:

- **Texas A&M University System**
Selecting Mold Remediation Contractors
<http://agrifecdn.tamu.edu/aes/files/2010/05/SelectingMoldRemediationContractors.pdf>
- **Cornell University/Louisiana State University**
Hiring a Mold Remediation Contractor
<http://extensionhealthyhomes.org/Documents/Mold-remediation.pdf>

Other sources of guidance related to mold response are:

- **Centers for Disease Control and Prevention**

Mold after a Disaster

<http://emergency.cdc.gov/disasters/mold/>

- **Federal Emergency Management Agency**

Mold & Mildew: Cleaning Up Your Flood Damaged Home

<https://www.fema.gov/media-library/assets/documents/12385>

After the Flood

https://www.fema.gov/media-library-data/20130726-1614-20490-6095/fs_aftertheflood_012013.pdf

Dealing with Mold & Mildew in your Flood Damaged Home

https://www.fema.gov/pdf/rebuild/recover/fema_mold_brochure_english.pdf

- **American Industrial Hygiene Association**

Facts About Mold

<https://www.aiha.org/publications-and-resources/TopicsofInterest/Hazards/Pages/Facts-About-Mold.aspx>

Professional Services Listing

<https://www.aiha.org/about-ih/Pages/Find-an-Industrial-Hygienist.aspx>
(specialty: mold)

- **Canadian Centre for Occupational Health and Safety**

OSH Answer Fact Sheets: Indoor Air Quality – Moulds and Fungi

http://www.ccohs.ca/oshanswers/biol_hazards/iaq_mold.html

- **U.S. Environmental Protection Agency**

A Brief Guide to Mold, Moisture, and Your Home

<https://www.epa.gov/mold/brief-guide-mold-moisture-and-your-home>

- **National Institute for Occupational Safety and Health**

NIOSH Interim Recommendations for the Cleaning and Remediation of Flood-Contaminated HVAC Systems: A Guide for Building Owners and Managers

<http://www.cdc.gov/niosh/topics/emres/Cleaning-Flood-HVAC.html>

- **Occupational Safety and Health Administration**

Fungi Hazards and Flood Cleanup

https://www.osha.gov/OshDoc/data_Hurricane_Facts/Bulletin3.pdf

Technical guidance for the industrial hygienist includes:

- Cummings, K.J., J. Cox-Ganser, M.A. Riggs, N. Edwards, G.R.Hobbs, and K. Kreiss: "Health effects of exposure to water-damaged New Orleans homes six months

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after hurricanes Katrina and Rita.” *Am J Public Health* 98:869-875 (2008).

- **American Industrial Hygiene Association**

Facts About Mold for the Professional

<https://www.aiha.org/publications-and-resources/TopicsofInterest/Hazards/Pages/Facts-About-Mold.aspx>

Recognition, Evaluation and Control of Indoor Mold, also known as the Green Book

<https://www.aiha.org/Lists/Products/DispForm.aspx?ID=50>

- **Institute of Inspection Cleaning and Restoration Certification**

ANSI/IICRC S500 Water Damage Restoration: Standard and Reference Guide for Professional Water Damage Restoration

<http://www.iicrc.org/standards/iicrc-s500/>

ANSI/IICRC S520 Mold Remediation: ANSI/IICRC S520 Standard and IICRC R520 Reference Guide for Professional Mold Remediation

<http://www.iicrc.org/standards/iicrc-s520/>

e. Food and Drinking Water

Guidelines for food and drinking water are available on these websites:

- **Texas Department of State Health Services**

Floods

https://www.dshs.state.tx.us/preparedness/factsheet_floods.shtm

- **U. S. Food and Drug Administration**

Food Safety for Consumers Returning Home After a Hurricane and/or Flooding

<https://www.fda.gov/food/resourcesforyou/consumers/ucm076993.htm>

- **U. S. Department of Agriculture Food Safety and Inspection Services**

Keeping Food Safe During an Emergency

http://www.fsis.usda.gov/wps/portal/fsis/topics/food-safety-education/get-answers/food-safety-fact-sheets/emergency-preparedness/keeping-food-safe-during-an-emergency/CT_Index

- **U. S. Occupational Safety and Health Administration**

Fact Sheet on Natural Disaster Recovery: Flood Cleanup

<https://www.osha.gov/OshDoc/floodCleanup.html>

f. Personal Protective Equipment

If you choose to perform clean-up activities on your own, be sure to wear appropriate personal protective equipment to protect yourself during the process. Guidelines for

protective equipment may be found at the following sites:

- **U.S. Environmental Protection Agency**
Flood Cleanup and the Air in Your Home
http://www2.epa.gov/sites/production/files/2015-09/documents/flood_booklet_en.pdf
- **Centers for Disease Control and Prevention**
Population-Specific Recommendations for Protection From Exposure to Mold in Flooded Buildings
https://www.cdc.gov/disasters/mold/report/pdf/2005_moldtable5.pdf

Guidance on Personal Protective Equipment and Clothing for Flood Cleanup Workers
<http://www.cdc.gov/niosh/topics/emres/ppe-flood.html>

Caution should be taken when wearing a respirator to perform any cleanup activity. While EPA and CDC both recommend the use of a National Institute for Occupational Safety and Health (NIOSH) certified N-95 respirator over a dust mask or surgical mask for mold cleanup, it is important to understand the limitations and additional risk of wearing a respirator. N95 respirators will not protect against chemicals or gases in the air, such as carbon monoxide or airborne vapors of chemical disinfectants. The respirator will not work if air leaks around the sides, so the manufacturer provides fitting procedures that must be followed and the correct size of respirator must be worn. Beards or other facial hair may prevent the respirator from fitting properly. People with chronic heart or lung conditions (such as congestive heart disease, asthma, and other conditions) should consult their health care provider before using a respirator. OSHA requires that employers provide training, fitting of the correct respirator size and testing of that fit, and a medical evaluation prior to fitting and use of the respirator. For additional information, be sure to thoroughly read the information presented in these resources before purchasing or using a respirator:

- **Minnesota Department of Health**
Use of an N95 Respirator: Cleaning Up After the Flood
<http://www.health.state.mn.us/divs/idepc/dtopics/infectioncontrol/ppe/comp/n95flood.html>
- **3M Occupational Health and Environmental Safety Division**
Respirators for Cleaning Up Mold in Your Home
<http://multimedia.3m.com/mws/media/3483260/respirators-for-cleaning-up-mold-in-your-home.pdf>
- **New York City Health**
Using the Right Dust Mask
<http://www.nyc.gov/html/doh/em/downloads/pdf/sandy/res-health.pdf>

WILDFIRE-SPECIFIC HAZARDS

Wildfire's impact to property, public health and the environment can expand several hundred miles from the actual burn zone. Direct property loss due to extreme heat damage can directly affect properties adjacent to the wilderness. However, communities several hundred miles downwind from the fire may also be consequentially affected as combustion particles are lofted high into the air by the fires extreme heat then driven great distances by prevailing winds. Feather-light ash produced by the intense heat of combustion and other smoke constituents including, solid particles, liquids, aerosols and gases can exist in the atmosphere for variable periods of time and continue to deposit long after the fire has been extinguished. The broad distribution capabilities and impacts of combustion by-products and emissions produced by wildfires can result in widespread public exposure to potentially toxic materials.

Wildfire particles can both migrate and infiltrate into the built environment through open doors and windows, on shoes and clothing, through the ventilation system and unperceived gaps in the building envelope. Studies have shown, penetration rates can be highly influenced by building characteristics, meteorology, and particle size/composition. Settled combustion particles on building surfaces or personal property can emit volatile materials which may be the source of persistent odors and/or result in an alteration in appearance or value.

a. During a Wildfire

During a wildfire event, keep all windows and doors in your home closed. If heating or cooling of the air is needed, ensure the ventilation system is turned on in recirculation mode (with outside air dampers closed) in order to filter the air. However, the advice is different for commercial buildings. The ventilation system operators should close or limit outdoor air intake to balance the need for fresh air with the hazards of entrained smoke. Portable air cleaners, such as those with High Efficiency Particulate Air (HEPA) or electrostatic filters, may also help reduce particulate levels in both homes and offices.

The Red Cross provides an excellent checklist for preparing for wildfires at:

- **American Red Cross**
Wild Fire Safety Checklist
http://www.redcross.org/images/MEDIA_CustomProductCatalog/m4340149_Wildfire.pdf

b. Inspection Prior to Re-occupancy After a Wildfire

Once the threat of fire has passed, local authorities will open fire-impacted areas for property access. Inspect the property and exterior of structures to ensure that there are no

active fires, smoke, or hidden embers. Pay particular attention to attics, roofs, and outbuildings. If you see fire or smoke, immediately contact local authorities. Also, inspect the property for heavily damaged trees. Trees or damaged limbs may fall onto people or structures. If you have questions about the safety of a tree, contact a local arborist or tree-removal firm.

Inspect the exterior electrical power lines leading to the structure. If power lines appear damaged, contact your local electrical utility provider. Check for the smell of natural gas or propane. If you smell gas, leave the door open and *exit* the structure. Do not go inside a structure that has a gas odor. Turn off the gas supply if it is located outside, and contact your utility provider.

Prior to entering any structure, the exterior should be inspected for structural fire damage. Fire damaged may compromise the structural integrity of roofs, walls, and foundations. Visible movement or sagging of the structure suggests serious damage. Evaluation by a qualified engineer or building official may be warranted prior to entry.

Do not enter the structure without respiratory protection if strong or irritant smoke odor is noticeable. The minimum recommended respiratory protection is a National Institute for Occupational Safety and Health (NIOSH) certified N-95 filtering face piece (dust mask), or a half-face air purifying respirator with combination particulate and organic vapor cartridges, if volatile organic vapors are present or suspected. The risk of adverse health effects from inhaling smoke particulates or vapors depends on the concentration of airborne chemicals and duration of exposure. Sensitive individuals will be at a higher risk of experiencing adverse health effects.

Individuals that are considered part of sensitive populations are generally those in the following groups:

- Infants and young children, due to under-developed respiratory systems and immune systems
 - Children (though while generally considered healthy, they have increased time outdoors and increased activity levels, i.e., faster breathing rate)
 - Individuals with chronic or preexisting respiratory medical conditions including, but it is not limited to asthma, chronic pulmonary obstructive disease (COPD), emphysema or chronic bronchitis
 - Individuals with other cardio-vascular or other vascular conditions including, but not limited to high blood pressure, coronary artery disease, congestive heart failure, or cerebrovascular conditions, such as atherosclerosis
 - Pregnant women
 - The elderly
 - Those with immunocompromised conditions
 - Other individuals with infections at the time of exposure
 - Smokers and former smokers
-

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There are buildings and settings where sensitive populations are present that should have special consideration if impacted by wildfire smoke. These include, but are not limited to:

- Daycare centers
- Hospitals
- Schools
- Nursing homes and assisted living units
- Senior centers
- Shelters

Useful resources on wildfire smoke, including a discussion of the use of respirators, is found at:

- **U.S. Environmental Protection Agency**
Wildfire Smoke: A Guide for Public Health Officials
https://www3.epa.gov/airnow/wildfire_may2016.pdf
- **New Mexico Department of Health**
Tips: Returning Home After a Wildfire
http://capitolriders.org/education/Returning_Home_After_a_Wildfire_01-18-13.pdf

c. Re-occupancy After a Wildfire

Be sure a clean water supply, electricity, and emergency medical services are restored, reliable, and readily accessible.

The fires may have deposited large amounts of ash that might contain hazardous or corrosive materials. Do not allow children in areas with visible ash accumulation that are not yet cleaned.

After the fire event, replace all air conditioning filters with higher filtration rated filters for at least a few weeks to remove entrained fire residue from the air and ductwork. Duct cleaning or replacement may also be required if a visible layer of fire residue remains. Consult a duct cleaning company for advice.

If using gasoline or diesel powered pumps, generators, or pressure washers, be sure to operate these machines only in well-ventilated areas to prevent exposure to carbon monoxide.

d. Cleaning After a Wildfire

The presence of noticeable smoke odor or accumulations of visible smoke particulate indicates that interior and exterior surfaces require cleaning. The odor will not dissipate until smoke particulates have been removed.

If your home was directly in the path of the wildfire, professional smoke restoration will likely be required. Following professional smoke restoration, there should not be

any visible accumulations of smoke particulate or noticeable smoke odors.

If your home was at a distance from the fire, general cleaning using damp wiping and a vacuum fitted with a High Efficiency Particulate Air (HEPA) filter may be all that is required. Because wind-driven and tracked-in fire particulate will continue for weeks to months following a wildfire, repeat cleaning may be required for homes located within the burned area.

If you have concerns about indoor air quality, consult a qualified local Indoor Environmental Professional or Certified Industrial Hygienist.

e. Restoration After a Wildfire

Conduct an initial assessment to gauge the time commitment and resources needed to sort and clean affected materials. This initial assessment will help determine if professional services are needed. Consider that corrosive residues from fires will continue to damage susceptible materials, and items impacted by water will need to be dried.

Professional cleaning services or professional fire or smoke remediation contractors can assist with heavy residues, non-washable fabrics, upholstery, furniture, area rugs, wall-to-wall carpeting, and other items that may be difficult to clean at home due to their size or because they require specialized cleaning equipment.

Several guidelines are available on cleaning and restoration after a fire as follows:

- **University of Missouri Extension**
After the Fire is Out: Cleaning Household Textiles and Clothing
<http://extension.missouri.edu/p/GH145>
- **Los Angeles County Department of Public Health**
How to Clean Up Smoke and Soot from a Fire
<http://publichealth.lacounty.gov/eh/docs/emergunit/cleanFireDamage.pdf>

Technical guidance for the industrial hygienist includes:

- **Restoration Industry Association**
Guidelines for Fire and Smoke Damage Repair, 2nd ed., 2007
<https://restorationindustry.site-ym.com/store/ViewProduct.aspx?id=4477272&hhSearchTerms=%2522Guidelines+for+Fire+and+Smoke+Damage+Repair%2522>
- **BC Centre for Disease Control Environmental Health Services**
Evidence Review: Wildfire Smoke and Public Health Risk

Health and Safety Issues in Natural Disasters

http://www.bccdc.ca/resource-gallery/Documents/Guidelines%20and%20Forms/Guidelines%20and%20Manuals/Health-Environment/WFSG_EvidenceReview_WildfireSmoke_FINAL_v3_edstrs.pdf

- **State of Washington Department of Ecology Air Quality Program**
How Wood Smoke Harms your Health
<https://fortress.wa.gov/ecy/publications/documents/91br023.pdf>
- Kovar, B., M.L. King, P. Chakravarty and M. Larrañaga: "Suggested guidelines for wildfire smoke damage and remediation." *Journal of Cleaning, Restoration and Inspection (IICRC)*, 2: 42-32 (2015).
<http://digitaledition.qwinc.com/publication/?i=260161&p=24>
Also available at <http://safeguardenviro.com/wp-content/uploads/2014/02/Wildfire-Smoke-Damage-Investigations-and-Remediation.pdf>

CLOSING REMARKS ABOUT AIHA

AIHA is the essential source for information on occupational and environmental health issues. AIHA members are health and safety professionals dedicated to protecting worker and public health. To reach out to AIHA safety and health consultants for professional assistance beyond these guidelines, a consultant list is available at <https://www.aiha.org/about-ih/Pages/Find-an-Industrial-Hygienist.aspx>. For more information about AIHA, visit www.aiha.org.

